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NTU's new inspection robot to be tested in JTC's industrial developments

Robot co-developed by NTU, JTC and CtrlWorks, with funding from NRF

New buildings in Singapore may soon have a high-tech building inspector rolling up to their door steps armed with laser scanners and high-tech cameras that can spot the tiniest cracks and defects.

This new building inspector is a robot invented by scientists from **Nanyang Technological University, Singapore (NTU Singapore)**, co-developed with Singapore's national industrial developer **JTC** and local start-up **CtrlWorks**.

Named **QuicaBot** – short for Quality Inspection and Assessment Robot – it can move autonomously to scan a room in minutes, using high-tech cameras and laser scanners to pick up building defects like cracks and uneven surfaces.

A few of these robots working together will make inspecting a building a breeze. The robots can upload 3D data of the scans to the cloud and inform the human operator, who can then inspect critical and complex defects.

The new robot was developed in one year at the NTU Robotic Research Centre, and is supported by the **National Research Foundation (NRF) Singapore**, under its Test-Bedding and Demonstration of Innovative Research funding initiative. The initiative provides funding to facilitate public sector's development and deployment of technologies that have the potential to enhance service delivery.

Project leader **Asst Prof Erdal Kayacan, from NTU's School of Mechanical and Aerospace Engineering**, said their key aim is to automate and speed up the building inspection process according to standards set by the Building & Construction Authority.

“Visual inspection of a new building is an intensive effort that takes two inspectors, so we have designed a robot to assist a human inspector to do his job in about half the time, saving precious time and manpower, and with great accuracy and consistency,” explained Prof Kayacan.

“The robot can scan an entire room to detect defects according to stringent and consistent standards, and then upload its data in 3D into a database. This means all defects will have their visual and detailed measurements recorded automatically, which can be accessed by the inspectors and the building owners.”

Mr Koh Chwee, Director, Technical Services Division of JTC and Co-Director of the NTU-JTC Industrial Infrastructure Innovation Centre (I³C), said that through collaborations with academic institutions like NTU on innovative technologies, JTC hopes to enhance construction productivity for industrial infrastructure projects.

“The use of such automation in construction projects can go a long way in raising the quality of inspections and alleviating the manpower crunch faced by the construction industry. JTC hopes that QuicaBot can enable high quality inspections that are more precise and consistent, while reducing the manpower and time needed to conduct such inspections.,” said Mr Koh.

Mr George Loh, Director (Programmes), NRF Singapore said, “NRF’s Test-Bedding and Demonstration of Innovative Research funding initiative seeks to identify technologies that have a strong potential to address a Singapore need. The public sector can drive the adoption of such disruptive technologies that provide solutions for real-life problems. We are excited that NTU and its partners have successfully integrated high-tech sensors with robotics technologies to meet a specific need in the building and construction industry, with the great potential to improve productivity through accurate detection of defects.”

Quick fault-finding robot

Common building defects include cracks on walls and ceilings, unevenness in the floor and walls, hollow tiles, and walls that may not be exactly square (i.e. not set at a 90-degree angle).

To detect them manually, a building inspector will have measurement tools like a spirit level and set square.

Tackling the same challenges with higher accuracy, the QuicaBot, which can operate for three days with two hours of charging, also has its own arsenal of high tech tools. They include:

- 1) small laser scanner for navigation and mapping
- 2) large laser scanner to inspect walls evenness and squareness
- 3) Inclinometer to check evenness of the floor
- 4) thermal infrared camera to check for hollowness in tiles
- 5) small standard colour camera to detect cracks on walls

To enable quick and nimble movements around the room, the team worked with CtrlWorks to develop the robot's mobile platform.

Professor Chen I-Ming, Director of the NTU Robotic Research Centre and co-leader of the project, said the robot has already done well in simulated environments.

“Using cameras and lasers which are more accurate than manual measurements, our robot has shown that it is able to assess the interior architectural defects of a building according to existing industry standards,” said Prof Chen.

For the next phase of development, QuicaBot will be test-bedded at suitable locations within JTC's industrial developments like JTC Space @ Gul, supported by the NTU-JTC I³C.

Established in 2011, the NTU-JTC I³C aims to pioneer cutting-edge industrial infrastructure solutions to address challenges faced by Singapore and its companies such as safety, productivity as well as manpower and resource constraints.

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About Nanyang Technological University

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,500 undergraduate and postgraduate students in the colleges of Engineering, Business, Science, Humanities, Arts, & Social Sciences, and its Interdisciplinary Graduate School. It has a new medical school, the Lee Kong Chian School of Medicine, set up jointly with Imperial College London.

NTU is also home to world-class autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI), Energy Research Institute @ NTU (ERI@N) and the Institute on Asian Consumer Insight (ACI).

Ranked 13th in the world, NTU has also been ranked the world's top young university for the last two years running. The University's main campus has been named one of the Top 15 Most Beautiful in the World. NTU also has a campus in Novena, Singapore's medical district.

For more information, visit www.ntu.edu.sg

About JTC

Set up in 1968, JTC is the lead government agency responsible for the development of industrial infrastructure to support and catalyse the growth of industries and enterprises in Singapore. Landmark projects by JTC include the Jurong Industrial Estate; the Jurong Island for energy and chemical industries; business and specialised parks such as Airport Logistics Park of Singapore, International Business Park, Changi Business Park, Seletar Aerospace Park, CleanTech Park and Tuas Biomedical Park; a new work-live-play-&-learn development called one-north; and the Jurong Rock Caverns, Southeast Asia's first commercial underground storage facility for liquid hydrocarbons. JTC also develops innovative space such as JTC Surface Engineering Hub, JTC MedTech Hub @MedTech Park and JTC Food Hub @ Senoko, which incorporate innovative features and shared infrastructure to enable industrialists to start their operations quickly and enhance productivity.

For more information about JTC, visit www.jtc.gov.sg

About National Research Foundation, Prime Minister's Office, Singapore

The National Research Foundation (NRF) is a department within the Prime Minister's Office. The NRF sets the national direction for research, innovation and enterprise (RIE) in Singapore. It seeks to invest in science, technology and engineering, build

up the technological capacity of our companies, encourage innovation by industry to exploit new opportunities that drive economic growth, and facilitate public-private partnerships to address national challenges.

Under RIE2020, NRF is committed to create greater value in Singapore from our investment in research, innovation and enterprise through 1) closer integration of research thrusts, 2) stronger dynamic towards the best teams and ideas, 3) sharper focus on value creation, and 4) better optimised RIE manpower. Visit www.nrf.gov.sg/research/rie2020 for more details.

NRF Singapore's Test-Bedding and Demonstration of Innovative Research funding initiative

NRF's Test-Bedding and Demonstration of Innovative Research funding initiative aims to use Government lead demand efforts to demonstrate feasibility of innovative technologies and catalyse adoption by private sector. Six projects are supported under this initiative. These projects involve partnerships with local industrial partners to ensure adoption or commercialisation of the developed technology solution.

About the NTU-JTC Industrial Infrastructure Innovation (I³) Centre

Launched in August 2011, the NTU-JTC I³ Centre was set up to promote the growth and development of economically viable and sustainable industrial infrastructure in Singapore. The centre will expand Singapore's R&D scope in fields such as land reclamation, energy and water recycling, underground infrastructure design and construction, and novel construction methods and systems. Fully funded by JTC, the centre leverages on NTU's technological knowledge and engineering expertise with JTC's infrastructure and business expertise.

For more information, visit <http://www.cee.ntu.edu.sg/ntujtc/Pages/Home.aspx>